A Diagnostic Protocol to Assess the Communication Deficits of Patients with Right Hemisphere Damage

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Information regarding the language abilities of the right hemisphere comes from investigations of split-brain (commissurotomy) patients, patients with hemispherectomies, patients with right and left hemisphere damage, and from language studies of normal adults. Caution must be exercised when making generalizations based on these specific findings due to the differing types of subjects.

A commissurotomy is generally performed due to multiple, bilateral epileptic foci such that focal, temporal resections would not relieve seizures. A commissurotomy removes some of the major pathways via which the left hemisphere can influence the right. Many investigators suggest that this permits the right hemisphere's linguistic capacities to emerge (Moscovitch, 1976). Generalizations from studies of commissurotomy patients must be done cautiously, because most of these patients have suffered cerebral insults early in life and unusual patterns of lateralization may have developed (Whitaker, 1981). Additionally, lesions due to the epileptic seizures might influence language performance.

Prior to the development of chemotherapy and radiation therapy, a hemispherectomy or the resection of a cerebral hemisphere used to be performed primarily for gliomas. Certain inferences could be drawn from studies of hemispherectomy patients concerning the ability of the nondominant hemisphere to take over speech and language functions, as well as the mode of normal development of cerebral laterality for speech and language. However, this does not allow for the interactions that normally occur between the two hemispheres.

Many investigators feel that much of the speech and language that remains following left hemisphere lesions is programmed by the right hemisphere; particularly with regard to globally aphasic patients who improve linguistically (Basser, 1962; Milner, 1974; Whitaker and Ojemann, 1977; Cummings, Benson, Walsh and Levine, 1979; Kinsbourne, 1971; Gazzaniga, 1977; Levine and Mohr, 1979). Kinsbourne (1971) concluded that speech in three right-handed aphasic men with left hemisphere lesions was programmed by the right hemisphere, because intracarotid amobarbital injections affecting the left hemisphere resulted in no speech arrest, whereas injections affecting the right hemisphere lead to complete arrest of speech and all vocalizations.

Investigations of language deficits following damage to the minor, right hemisphere suggest a variety of phonemic, semantic, linguistic, and organizational language functions in the nondominant hemisphere. Experimental and clinical investigators of hemispheric asymmetry generally agree that the left hemisphere is specialized for propositional, analytic, and serial or linear processing of incoming information, while the right hemisphere is more adapted for the perception of appositional, holistic, synthetic, simultaneous, or gestalt relations (Bever, 1975).

Many linguistic capabilities and limitations of the right hemisphere have been reported and it appears, as Myers (1979) has suggested, that patients with right hemisphere damage should receive the attention of the speech and language pathologist. Deal, Deal, Wertz, Kitselman, and Dwyer (1979), reported, however, that when attention is given to the speech and language abnormalities of right hemisphere lesions, the clinician finds sparse normative data. Based on their investigation, they concluded that the Porch Index of Communicative Ability might not be the best instrument to detect the presence or absence of language disturbances in right hemisphere damaged patients.

The purposes of this investigation were: 1) To compare the responses of patients with cerebrovascular accidents to the right hemisphere with the responses of non-brain-damaged control subjects on tasks which assess auditory comprehension, verbal expression, reading comprehension, and other cognitive behaviors which interfere with communication. 2) To develop a comprehensive test of communicative capabilities and limitations for right-brain-damaged patients. Language batteries currently used with left-brain-damaged patients do not sufficiently evaluate communication deficits which may be experienced by right-brain-damaged individuals, due to the subtle nature of their deficits.

Subjects. Five subjects (3 male and 2 female) who sustained right hemisphere damage from a single cerebrovascular accident and five non-brain-injured controls (3 male and 2 female) were examined. Only those subjects who displayed unilateral damage based on CT Scan and neurological examination were selected for inclusion in the experimental group. Subjects were further required to be at least six months post cerebrovascular accident, right handed, and English speaking only.

Subjects were matched with regard to age, level of education, and sex. The mean age of the right-brain-injured group was 65.5 years with an age range of 51 to 73 years. The mean education level was 11 years. The mean time post onset of stroke was 7.2 months. Homonymous hemianopsia and left neglect (which was compensated for during testing by object placement and verbal cues to scan) were present in two patients. The mean age of the control group was 66.8 with an age range of 53 to 80 years. The mean educational level was 12.8 years.

METHOD

Each patient was tested in two one-hour sessions. During the first hour, Examiner A administered the following tests: The Boston Diagnostic Aphasia Examination (BDAE) including auditory comprehension subtests (word discrimination, body part identification, commands, and complex ideational material), oral expression subtests (automatized sequences, repetition of words, repeating phrases, and responsive naming), reading subtests (word-to-picture matching and reading sentences and paragraphs). The Revised Token Test (RTT) and the Hooper Visual Organization Test. In this test, subjects are required mentally to assemble parts and name a picture.

During the second hour, Examiner B administered the following tests: The Detroit Test of Learning Aptitude (DTLA) including the verbal absurdities subtest, portions of the verbal opposites subtest, and portions of the likenesses and differences subtest. In the verbal absurdities subtest subjects are asked to tell what is absurd about statements such as "If I am in a hurry, I get a horse because automobiles are too slow." This subtest requires

continual listening and synthesizing, short term auditory memory, knowledge of embedding, and good cognitive abilities. The verbal opposites subtest in which the patient is asked to respond to a statement such as: "the opposite of day is _____." identifies convergent production deficits for semantic classes with words generally sequenced according to relative frequency, reading level, and along a continuum from concrete to abstract. In the likenesses and differences subtest the subject is asked to explain the most important ways in which two words such as "morning and afternoon" are alike and different. This subtest shows concept formulation problems, tests cognition of semantic transformations, and evaluates the ability to abstract and describe ways in which concepts denoting objects, quality, or ideas share essential characteristics or, through mental rotation, are essentially different. The Borkowski, Benton and Spreen Word Fluency Task; in which subjects are given one minute to list words beginning with the letters S, T, P, and C; the Boston Naming Test; and several informal assessment tests, including non-standardized assessment of: verbal sequencing (in which subjects were asked to tell all the steps necessary to make a telephone call from a telephone booth), verbal problem solving (in which subjects were to give three possible solutions to the problem of locking their keys in their car), visual closure (in which subjects were required to name the word which would be made if missing letters were filled in), visual reorganization (which required a reorganization of letters to form a word), immediate and short-term memory for related and unrelated words (in which subjects were asked to repeat increasingly longer sets of word strings under no delay and 30 second delay conditions).

RESULTS

A Mann-Whitney U test was performed and showed that several of the 47 test variables clearly discriminated between normal controls and right-brain-damaged patients. The statistical analysis yielded z scores which were significant for the following test variables:

Auditory Comprehension. Table 1 summarizes the tests which were found to differ significantly between the two groups. When errors were made on the word discrimination tasks by the right-brain-damaged group, they tended to be in response to letters and numbers. Zaidel (1976) also found letters and numbers to be more difficult than object names, actions, geometric forms and colors for subjects with right hemisphere damage. Goodglass, Klein, Carey and Jones (1966) revealed the same relative order of deficits with left-hemisphere-damaged subjects. The significantly lower scores attained by the right brain-damaged group on complex ideational material primarily appeared to be due to linguistic complexity. Other errors appeared to be related to length of stimuli and intermittent inattention.

The analysis of the RTT revealed that linguistic complexity mean scores rather than mean scores on the ten subtests were most discriminating between the non-brain-injured and the right-brain-injured groups. Therefore, the linguistic features of each item, rather than the number of elements in the stimulus appeared to interfere with performance. This finding was supported by the analysis of the responses on two memory subtests. The normal and the right-brain-damaged subjects did not significantly differ on these memory tasks. The findings with regard to the Revised Token Test were in partial agreement with those of McNeil and Prescott (1978).

Table 1. A summary of the findings regarding auditory comprehension tests administered to right-brain-damaged and normal control subjects.

Tests Administered	Significance of Difference Between Groups
BDAE	
Word Discrimination	.01
Body Part Identification	.05
1-2 Step Commands	-
Complex Ideational Material	.01
RTT (Entire test administered. Only significantly different variables listed.)	
Over-all score	.01
Subtest IV	.05
Subtest V	.05
Subtest X	.01
Direct Command Verb	.05
Implied Command Verb	.05
Adverbial Clause	.01
Shape I Adjective	.01
Shape II Adjective	.01
Size I Adjective	.01
Color I Adjective	.01
Color II Adjective	.01

Verbal Expression. Table 2 summarizes the tests which were found to differ significantly between the two groups.

With regard to naming abilities, the confrontation naming errors of the right-hemisphere-damaged individuals tended to be visually similar to the stimulus or similar to the circumlocution errors made by aphasic patients (Table 3). One caution needs to be added to these findings, however. Visual organization deficits were displayed by the right hemisphere patients. They obtained significantly poorer mean scores than the control group on the Hooper Visual Organization Test. When in error on the Hooper Visual Organization Test, subjects tended to assign names to the separate parts of each item or to perseverate on previously named items (Figure 1).

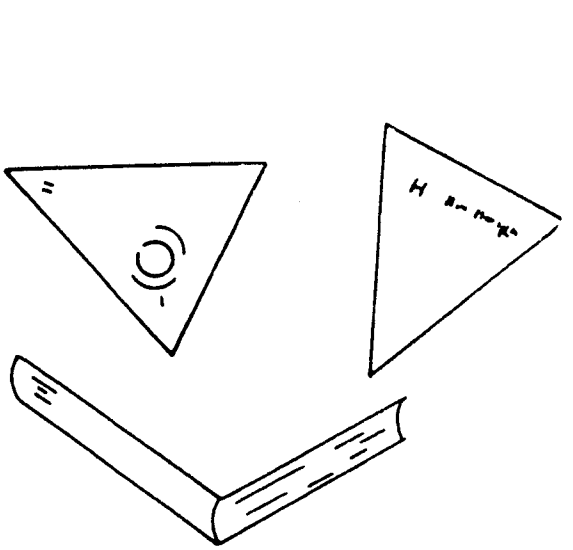
Expressive language deficits also emerged in the right-brain-damaged patients with regard to high level verbal sequencing and organizing abilities. Deficits were seen in DTLA likenesses and differences and verbal opposites subtests. An analysis of specific error responses on the likenesses and differences subtest suggest impairment in the right-brain-damaged patients due to internal (cognitive) and external (verbal) sequencing skills. Internal (cognitive) sequencing skills are defined as the ability to formulate silently a series of related thoughts. In order to describe how two items are similar, an individual must mentally list the critical elements of both items and then select the similar items from each list. The experimental group was often unable to perform this task. They eigher refused the task or gave responses which were personalized (Table 4).

Table 2. A summary of the findings regarding verbal expression tests administered to right-brain-damaged and normal control subjects.

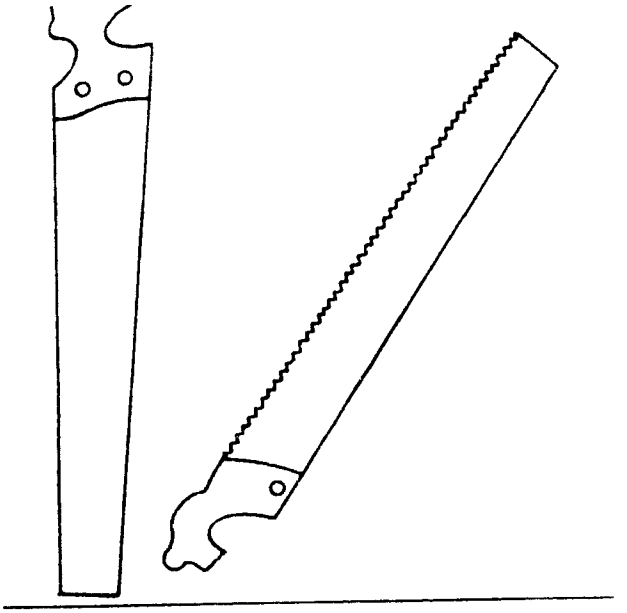
Tests Administered	Significance of Difference Between Groups
BDAE	
Automatic Sequencing	.05
Repetition of Words	-
Repetition of Phrases	-
Responsive Naming	.05
Boston Naming Test	.05
Word Fluency Test	.05
DTLA	
Verbal Absurdities	-
Verbal Opposites	.05
Likenesses and Differences	.05
Associated Linguistic Tests	
Verbal Sequencing	-
Verbal Problem Solving	-

Table 3. Examples of error responses of right-brain-damaged group on the Boston Naming Test.

	Stimulus	Response
I. Visually Similar Errors		
	Nozzle	Telescope
	Accordian	Rack of Books
	Pyramid	Dune
	Trellis	Ladder
II. Other Errors		
	Compass	I've used them for 28 years.
	Hourglass	Every day I boil eggs.
	Brief Case	File case



"Book and a triangle" or "Banners"



"Saws, one with teeth and one with no teeth"

Figure 1. Examples of response errors made by right brain-damaged subjects on the Hooper Visual Organization Test.

Table 4. Examples of the right brain-injured group's error responses on the likenesses and differences subtest of the Detroit Test of Learning Aptitude.

1. Most errors in response to likenesses of the right brain-damaged group were:

   "can't compare"

   "not much in common"

2. Responses were personalized:

Stimulus	Response
Morning Afternoon	"You get to lie down in the afternoon"
	"I'm more ambitious in the afternoon"

This behavior was noted in spite of the fact that subjects comprehended both items, as shown by their ability to correctly tell how the items were different. Describing the differences between two items is thought to be a cognitively less complex task in terms of internal organization and memory (Muma, 1979). Another explanation of the poor performance on this subtest might be visual memory disorders. Myers (1978) suggests that right hemisphere damaged subjects have difficulty keeping cognitive maps or pictures in mind.

In addition to response delays, specific error responses on the verbal opposites subtest tended to be synonyms instead of antonyms (Table 5). Caramazza (1976) suggests that right hemisphere damage disrupts verbal problem solving because verbal reasoning frequently requires referring to an image. It appears that a person could give a synonym in response to the mental formation of one image, yet two mental images would be necessary during the process of the formulation of an antonym.

Table 5. Examples of the right brain-injured group's error responses on the Verbal Opposites Subtest of the DTLA.

Stimulus	Response
False	Lie
Lend	Gave
Gradual	Slow
Dangerous	SOS
Create	Artistic

The final area of expressive language impairment was reflected in the significantly different scores obtained by the two groups on the Word Fluency Task. The right-hemisphere-damaged individuals obtained consistently lower scores than did the non-brain-injured adults. This finding was consistent with that of Milner (1974), in which word fluency measures were suggested to be sensitive to the deficits of right-brain-damaged patients. An analysis by inspection of the word lists generated by both groups revealed that the normals appeared to utilize several strategies (i.e., semantic and phonemic), to generate responses whereas the right brain-damaged group used only one strategy or no discernible strategies.

Reading

Table 6 summarizes the tests which were found to differ significantly between the two groups. The right-hemisphere-damaged group did significantly worse than did the normal group on the sentence and paragraph reading subtest of the BDAE. The experimental group made more errors as the stimuli became more complex. The majority of errors were made on the last two test items on the subtest, indicating that performance decreased as the number and complexity of elements which needed to be internally sequenced, organized, and intergrated increased. Reading deficits did not appear to be related to visual perception and discrimination problems, in that both the experimental and control group were equal in their ability to match picture to printed word on the Word Reading Subtest of the BDAE. Also the missing sounds (visual closure) and scrambled words on visual reorganization tests were not significantly different. Subjects were able to read aloud such that the examiner could determine that they were, in fact, seeing what was written on the page.

Table 6. A summary of the findings regarding reading tests administered to right-brain-damaged and normal control subjects.

Tests Administered	Significance of Difference Between Groups
BDAE	
Word to Picture Matching	-
Sentences and Paragraphs	.01
Associated Tasks	
Missing Sounds	-
Scrambled Words	-

SUMMARY

In summary, patients with damage in the right hemisphere exhibited deficits in auditory comprehension, verbal expression, and reading comprehension, which appear to result from cognitive and linguistic deficits rather than deficits in visual perception and organization or memory. Although there is a need to study additional subjects, these findings suggest that the speech and language pathologist should be involved in the evaluation and treatment of these patients. Based on this investigation, a test battery which is sensitive to some of the subtle linguistic deficits evidenced by right brain-damaged patients is recommended.

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DISCUSSION

Q: You set up some beautiful hypotheses and had a lot of tests. If you increase your N and do a factor analysis on all of this data, you'll be able to determine if the actual areas that you delineated, in fact, differentiated the right CVA subjects from normal people. This might strengthen your hypotheses. It might also eliminate a lot of excess testing as some tests might test the same thing.

A: We do plan to test more subjects. Additionally, we want to control for site of lesion. We feel this might be important based on the current knowledge regarding localization of functions in the right hemisphere. The frontal lobe plays a role in memory, affect, humor, and attention; the temporal lobe in memory; the temporal-parietal lobe in transient dysarthria; the parietal lobe in visual abilities with lesions producing homonomous hemianopsia and/or neglect; and the occipital lobe in visual functioning.

Q: Do you plan to see how patients with left CVA's do on your battery?

A: Yes.

Q: How much cueing did you actually do for the visual neglect?

A: Very little. Only one patient had visual neglect due to a temporo-parietal lesion. Since the neglect was not severe, placement of objects and only a few cues to scan were all that was necessary to compensate for this problem.